Table 20.1 Declination and extraterrestrial irradiation values for the characteristic day of each month

Month	Date	d_n	δ [degrees]	$B_{0d}(0) = B_{0dm}(0)$, in [Wh/m^2]			
				$\phi = 30°$	$\phi = 60°$	$\phi = -30°$	$\phi = -60°$
January	17	17	−20.92	5 907	949	11 949	11 413
February	14	45	−13.62	7 108	2 235	11 062	9 083
March	15	74	−2.82	8 717	4 579	9 531	5 990
April	15	105	+9.41	10 225	7 630	7 562	3 018
May	15	135	+18.79	11 113	10 171	5 948	1 225
June	10	161	+23.01	11 420	11 371	5 204	605
July	18	199	+21.00	11 224	10 741	5 530	878
August	18	230	+12.78	10 469	8 440	6 921	2 294
September	18	261	+1.01	9 121	5 434	8 835	4 937
October	19	292	−11.05	7 436	2 726	10 612	8 226
November	18	322	−19.82	6 056	1 114	11 754	10 983
December	13	347	−23.24	5 498	613	12 174	12 177

where d_{n1} and d_{n2} are the day numbers of the first and last day of the month, respectively. It is useful to know that, for a given month, there is a day for which $B_{0d}(0) = B_{0dm}(0)$. It can be demonstrated that this day is the one whose declination equals the mean declination for the month. Table 20.1 shows the day number of this day and the corresponding value of $B_{0dm}(0)$ for each month of the year at several latitudes.

We have also shown that the effect of clear cloudless skies can be predictably accounted for by a single geometrical parameter, namely, the Air Mass (equation 20.12). On the other hand, there are random variations caused by climatic conditions: cloud cover, dust storms and so on so that the PV systems design should rely on the input of measured data close to the site of the installations and averaged over a long time. This is routinely done by the National Meteorological Services (or similar services), which use a variety of instruments and procedures, from direct sunlight measurements (pyranometers, pyrheliometers etc.) to correlations with other meteorological variables (hours of sunshine, cloudiness, tone of satellite photographs etc). Then, they are treated to derive some representative parameters, which are made publicly available by different ways: World radiation databases [7, 8], Regional [9], National [10–12] and local [13] Radiation Atlas, web sites [14, 15] and so on. The 12 monthly mean values of global horizontal daily irradiation, $G_{dm}(0)$, today represent the most widely available information concerning the solar radiation resource, and that is likely to remain in the years to come. It is important to note that solar radiation unavoidably represents a large source of uncertainty for PV systems designers, as revealed by the significant disparity between different information sources. As a representative example, we will consider the case of Madrid.

The Spanish National Meteorological Institute has been recording daily values of hours of sunshine from 1951 to 1980, and hourly global horizontal irradiation data since 1973. This means that the Madrid solar radiation data bank is today composed of more than 50 years of daily indirect observations and more than 25 years of hourly direct ones. Such comprehensive data may appear very gratifying. However, an in-depth examination of the data bank reveals several difficulties: significant data gaps (the most important extends from June 1988 to July 1989); changes of the sensor's calibration constant (in